DOCUMENT RESUME

ED 177 128 SP 014 726

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TITLE	Learner Cognitive Attainment: A Basis for Establishing a Student Teacher's Competence.
PUB DATE	79
NOTE	26p.
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Academic Achievement; Classroom Observation Techniques; *Effective Teaching; Expectation; *Student Teachers; Teacher Behavior; Teacher Education; *Teacher Evaluation; Teaching Experience; *Teaching Styles

ABSTRACT

The feasibility of evaluating the performance of student teachers by observing the academic achievement of pupils was explored. The following questions were posed: Do expectancies of learners held by student teachers influence pupil achievement on a single instructional unit when prior achievement of pupils is held constant? Does the amount of prior solo teaching time and opportunity-to-learn time provided by the student teacher influence pupil achievement on a single instructional unit when prior achievement of pupils and expectancies held by student teachers are held constant? Does the planning and instructional effectiveness of the student teacher as perceived by the university supervisor affect pupil achievement on a single instructional unit when the other variables under consideration are held constant? Does this group of variables provide a model to explain the relationship between student teaching styles and pupil achievement? (JD)

ED177128

Learner Cognitive Attainment: A Basis for Establishing A Student Teacher's Competence

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Abstract

Procedures from educational policy research were applied in this investigation to develop four conceptual models for determining the success of student teachers affecting learner cognitive attainment. Structural equations for these models were developed to analyze the data collected from 629 secondary school learners and 7 student teachers. Comparisons of the various regression models yielded results indicating instructional time-referenced variables ($F=5.38$, $p<.01$) and supervisor ratings of the planning and instructional effectiveness of student teachers ($F=11.11$, $p<.01$) do account for some cognitive attainment variability among secondary learners of student teachers. Additionally, these procedures hold promise for combining numerous variables to determine the instructional competence of a student teacher.

Teacher educators and former students alike often agree that the most vital component of current teacher preparation programs is student teaching. Almost universally teacher preparation institutions provide their candidates with student teaching experiences, but the nature of these experiences varies substantially. Ironically, while the organization, goals, and processes of student teaching differ from program to program the assessment procedures for determining the prospective teacher's competence are usually based on classroom and university supervisor ratings. This evaluation practice is largely due to precedence, and the sheer difficulty of collecting, integrating and interpreting other sources of information to render judgements of a student teacher's competence. In this investigation our efforts have been directed to determining whether it is feasible to ascertain the competence of the student teacher on the basis of learner cognitive attainment, assuming the supervised instructional unit being taught is appropriate for the learners.

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THEORETICAL CONSIDERATIONS

A precedent for using learner cognitive attainment as a measure of teaching success dates back to the scientific management era in American schools from 1910 to 1930 (Callahan, 1962). Apparently, this interest continued for some time given the investigations by Rostker (1945), Rolfe (1945), and LaDuke (1945). These investigators collected multiple teacher and learner variables while examining teaching ability based on learner achievement. Interestingly, these investigators employed rather elaborate statistical procedures, i.e., multiple regression, to explain the effects of teacher variables on learner achievement.

During the past decade or so, interest in assessing teacher performance in terms of learner achievement has re-emerged. Competency Based Teacher Education (CBTE) no doubt has been instrumental in refocusing the attention of teacher educators to assessment concerns in the preparation of teachers. Two major positions emanating from CBTE regarding assessment of teacher competency are: (1) assessement procedures which emphasize the use of classroom process criteria and (2) assessment procedures which emphasize the use of consequence criteria (learner attainment data) (Weber, 1974).

Educators favoring the use of process criteria, such as, the candidates' facility with creating a favorable learning set with the class, or facility of phrasing higher order questions, to determine the competence of a student teacher have concluded process data are sufficient indicators of the teaching skills of the candidate. This position is often endorsed because of the measurement difficulties and economical considerations associated with obtaining achievement gains from standardized tests (Glass, 1974; Soar, 1973).

Others who have labored with the issues of assessing teacher competence

have concluded that process criteria alone do not yield adequate evidence of teaching competence. Educators espousing this position indicate that it is necessary and feasible to use learner attainment data in the assessment of teacher competency within a teacher education context. Proponents of this position recognize the difficulties in measuring and analyzing learner growth, but contend these problems can be dealt with in ways that are cost-effective.

Perhaps an approach which integrates learner cognitive attainment data with systematic classroom observations is the optimal assessment strategy. Such a strategy has been devised by McNeil and Popham (1973, pp 233-234). These evaluators have described an alternative for assessing teacher competence which involves contract plans based on learner cognitive gain. With little or no modification, this contract plan can serve as a blueprint for assessing a student teacher's competence. The basic premise of this approach is that the objectives of the curricular plan must be agreed on before teacher competency can be assessed. Supervisors and the teaching candidate must agree on the appropriateness of stated performance objectives for the learners. Further, agreement is reached before instruction begins regarding what evidence will be used to determine whether the teaching has resulted in learner attainment of the performance objectives. Data are subsequently collected to determine whether learners have achieved the stated objectives as well as whether unintended outcomes have emerged. The evaluation plan need not exclude the use of observational systems in the assessment of instruction, rather the plan recommends their use as means for establishing descriptive records of the teaching act.

The primary advantage of the contract plan for assessing teacher competence is that it allows the student teacher in conjunction with the supervisors to establish outcomes and standards that are most appropriate for

a particular group of learners. Prior learning of students, dynamics of the classroom, and classroom environment can be taken into account in establishing the instructional plan on which the student teacher is to be held accountable (McNeil, Popham, 1973).

This investigation has been fashioned to determine the influence on learner cognitive attainment of variables common to the student teaching experience. Data pertinent to these variables were obtained by implementing an assessment procedure which incorporates the tenets of the McNeil-Popham contract plan. To this end, the following research questions were posed.

1. Do expectancies of learners held by student teachers influence learner cognitive attainment on a single instructional unit when prior cognitive attainment of learners is held constant?

2. Does the amount of prior solo teaching time and opportunity to learn time provided by student teachers influence learner cognitive attainment on a single instructional unit when prior cognitive attainment of learners and expectancies of learners held by student teachers are held constant?

3. Does the planning and instructional effectiveness of the student teacher as perceived by the university supervisor affect learner cognitive attainment on a single instructional unit when prior learner cognitive attainment, expectancies of learners held by student teachers, prior solo teaching, and opportunity to learn are held constant?

4. Does a group of variables (e.g., prior cognitive attainment of learners, student teacher expectancies, planning and instructional effectiveness ratings, and measures of time on instruction) provide a model to explain a learner's cognitive attainment on a single instructional unit?

ORGANIZATION OF INVESTIGATION

Program Description

This investigation was conducted under the auspices of an educational curriculum and instruction department at a Land Grant University. The teacher preparation program which participated in the investigation is a

competency based program for secondary level teachers fashioned around a diagnostic prescriptive model of instruction (Armstrong, Denton, Savage, 1978). This model conceptualizes teaching as a series of events requiring five distinct sets of instructional skills, that is: Specifying Performance Objectives, Diagnosing Learners, Selecting Instructional Strategies, Interacting with Learners, and Evaluating the Effectiveness of Instruction.

The model provides a framework that encourages the development of individual teaching styles. Individualized styles are encouraged because evaluation of instruction is based on learner achievement of the performance objectives. Given this operating principle, teachers in preparation are free to choose procedures from their own repertoires that they believe will result in high levels of learner performance. Further, teacher responsibility is well served by this model. This responsibility comes not because of the teaching candidate's adherence to a set of "ideal role behaviors," but rather in adapting instructional practice, as necessary, to help learners achieve performance objectives that have been selected.

A full semester-full day student teaching program with twelve semester hours being awarded for successful completion of the experience is the culminating experience in this preparation program. During this experience, each student teacher is required to develop and implement two instructional units each of approximately two weeks duration. The instructional units are to include: performance objectives, a diagnostic pretest to determine whether prerequisite knowledges and skills are present, instructional strategies addressed to each performance objective, and criterion-referenced instruments. These units must be deemed acceptable and appropriate by both the classroom supervising teacher and the university supervisor prior to implementation.

The evaluation of the student teacher in this program typically consists of the supervisor completing an Evaluation Profile on the instructional competence of the student teacher, and a Curriculum Context Checklist on the instructional unit developed by the student teacher. (These instruments are described in an ensuing section.) In addition to these data, student teachers are required to complete a summary evaluation form for each unit taught. This self-evaluation experience is designed to emphasize the importance of program evaluation.

Interestingly, only one type of data was collected for this investigation which ordinarily is not collected during student teaching, that being criterion-referenced learner attainment data. In this investigation, student teachers who participated in the investigation retained the unit test responses of learners after providing feedback to the learners regarding their performance. These examinations were subsequently submitted to the university supervisor.

Sample

A total of 629 secondary school learners and 7 student teachers provided data for this investigation. Complete classroom sets of cognitive attainment data from the implementation of two instructional units were collected across six subject areas, i.e., chemistry (1 student teacher, 87 learners), earth science (1 student teacher, 87 learners), English (1 student teacher, 101 learners), government (2 student teachers, 143 learners), life science (1 student teacher, 104 learners), state history (1 student teacher, 107 learners). The total number of secondary level student teachers numbered 68 during the semester (Spring 1978) this investigation was conducted, with ten percent of these candidates participating in the investigation. Reasons for the small number of student teachers in this sample range from selecting candidates

assigned to a single university supervisor, thereby reducing error variance among supervisor ratings, to the sheer volume of cognitive attainment data collected from learners of the student teachers.

Instrumentation

A variety of scales and criterion-referenced instruments mentioned in the preceding section were used in obtaining measures of the various independent variables and the dependent variable in this investigation. The following paragraphs briefly describe these instruments.

An Evaluation Profile was employed to obtain the independent variable, instructional effectiveness of the student teacher as perceived by the university supervisor. Supervisor ratings for the items under the heading instructional competencies, were summed together to provide the value for the instructional effectiveness variable. The instructional skills addressed on this instrument are consistent with the skills stressed in the methods coursework which precede student teaching. An alpha coefficient, $\alpha=.94$, determined for this instrument suggests a high degree of internal consistency among responses to the various items. Further, a high degree of correspondence usually results between classroom supervisor and university supervisor ratings of a student teacher on this instrument.

A second rating scale, the Curriculum Context Checklist, was used to to provide university supervisor ratings of the curricular units developed by the student teacher. Values from this scale provided data for the independent variable, planning effectiveness of the student teacher. This instrument contains a 5 choice scale identical to the scale of the evaluation profiles. Individual items of this instrument identify components of the curriculum unit, e.g., general goals, focusing generalizations, concept list, diagnostic component.

Two of the independent variables addressed in this investigation, Prior Solo Teaching and Opportunity-To-Learn time along with data for yet another independent variable, expectancies of learners held by student teachers, were obtained from a Summary Evaluation of Unit form completed by the student teacher. This evaluation form was completed by the teaching candidate soon after completing the instruction associated with each unit. Among other items, the form required the student teacher to estimate the achievement level and socio-economic level of learners, and report the number of individuals achieving each objective in the instructional unit. In order to complete this form, candidates had to engage in program evaluation which, in essence, was the primary function of the form.

Finally, criterion-referenced tests developed by the student teacher provided data for both an independent variable, prior cognitive attainment from Unit 1, and the dependent variable, learner cognitive attainment in Unit 2. These instruments, unique for each unit and each student teacher, represent a strength and potential limitation in the design of this investigation. As a strength, the student teacher with guidance from classroom and university supervisors developed tests related directly to the outcomes established for the performance objectives in each unit. Prior learning, extenuating classroom situations, and the abilities of the learners were taken into account in establishing both the objectives and the corresponding criterion tests. Under these conditions, the cognitive attainment measure indeed did sample the behavior called for in the performance objectives.

A potential limitation of candidate-developed criterion-referenced tests for this investigation stems primarily from the lack of information on the reliability and validity of the respective instruments. Conventional reliability procedures appropriate for norm-referenced tests were not

determined on the various criterion-referenced tests because the function of these tests (to determine an examinee's level of functioning with respect to a stated criterion) is not consistent with the function of norm-referenced tests (to determine an individual's performance with respect to the performance of others in the group) (Millman, 1974). Thus, while we are concerned, we are not unduly alarmed by the absence of these values. Validity of criterion-referenced instruments on the other hand, can be assessed by determining the logical relation of the performance objectives and the individual test items. Fortunately, this validity check was conducted by the classroom and university supervisors on each candidate's test before the instrument was administered to the learners.

STATISTICAL DESIGN

Conceptual Regression Models

During the past decade, substantial interest has centered on the development of conceptual models for documenting the educational process. Typically, these models have been constructed to explain an individual's educational achievement in terms of the following factors: individual and family characteristics, peer group influences, genetic endowments, school resources, and study attitudes (Barro, 1970, Hanushek, 1972).

One difficulty encountered with the early conceptual models for explaining educational achievement was the selection of an appropriate statistical model. Multiple regression techniques, which were relied on for similar model building in agriculture and economics, often yielded inconsistent estimates when applied to empirical data from the schools. The primary reason for these unstable estimates was determined to be the high interrelationships among educational process variables, which is known as the multicollinearity problem in statistical analysis. This problem has been

resolved by specifying the educational variables as a system of simultaneous equations that lead to more accurate parameter estimates among the independent variables (Cooley and Lohnes, 1976; Murnane, 1975).

This refinement of regression procedures has enabled us to develop a system of four linear structural equations to resolve the research questions for this investigation. Each structural equation takes the form of a regression model to satisfy estimation requirements. These models and a corresponding legend are presented in Figure 1.

Place figure 1 about here

In model 1, learner cognitive attainment on a second unit developed and implemented by a student teacher depends on the learner's prior cognitive attainment (performance on the initial unit taught by the student teacher). The effect of the instruction in the second unit is depicted by a constant, a. Inherent in this regression model is the assumption that the effect of an instructional unit is independent of the student teacher's expectancies, her/his planning and instructional skills, and the time allowed for instruction.

Model 2 presents learner cognitive attainment on a second instructional unit taught by a student teacher as a function of the learner's prior cognitive attainment and student teacher's expectations regarding the ability of her/his learners. Underlying this model is the assumption that the effect of a second instructional unit depends only on the expectancies held by the student teacher regarding the abilities of the class of learners. Justification for the inclusion of a teacher expectancy variable in this investigation rests with reviews of literature which link the influence of expectancy with the subsequent behavior of the teacher toward the learners (Good, Brophy, 1973: Paulson, 1978).

Model 3 presents learner cognitive attainment as a function of the aforementioned variables (prior attainment of learner, student teacher expectancy) and two measures of time (prior solo teaching time of the student teacher, and the opportunity to learn time). The assumption underlying Model 3 is that the effect of instruction in unit two depends on prior instructional time and the time allotted for instruction in the second unit as well as student teacher expectancy of learners. These time-based variables were included in this model because of the theoretical considerations of time in the oft-cited model of school learning by John Carroll (1963). Further, recent literature on teacher effectiveness indicates time-on-task of both teacher and learner is correlated with classroom achievement. (Medley, 1977; Stallings, 1977).

Finally, in model 4, learner cognitive attainment depends on the planning and instructional skills of the student teacher as perceived by the university supervisor as well as all of the independent variables included in model 3. The assumption behind model 4 is that the effect of instruction in unit two depends on the planning and instructional skills of the student teacher, in addition to prior instructional time, opportunity to learn time and the student teacher's expectancies of learners. Supervisor ratings were included in this model because of the acceptance of this type of evaluative procedure in assessing the competence of student teachers. If supervisor ratings do accurately reflect the teaching candidate's planning and instructional skills, then these variables should account for some of the variance in learner cognitive attainment.

Statistical Analysis

These four regression models were analyzed and tests of significance were performed to statistically address each of the research questions. The expressions

used for these tests are presented in figure 2.

To test research question 1, we compare models 1 and 2. If the observations are consistent with our expectation, then the coefficient of determination or the explanatory power of model 2 should reflect a significant increase over the explanatory power of model 1 which does not take into account the influence of student teacher expectancies of learner cognitive abilities.

To test research question 2, we compare models 2 and 3. If the observations are consistent with our expectation, then the explanatory power of model 3 should provide a significant gain over the explanatory power of model 2. These models differ due to the contribution of the time based variables to explain learner cognitive attainment.

Finally, to test research question 3, we compare models 3 and 4. Again, if the observations are consistent with this research question, then the explanatory power of model 4 should exceed the explanatory power of model 3 due to the planning and instructional effectiveness of the student teacher.

FINDINGS

The analysis associated with research question 1 produced a F value ($F = .82$) which was not statistically significant. This result reveals that expectancies of learners held by student teachers do not influence the cognitive attainment of the learners, at least not in this investigation.

The statistical comparison for research question 2 produced different results. The F value of this comparison, ($F = 5.38$, $p < .01$) indicates the explanatory power (1.3 percent of the variance) of these time-referenced variables is statistically significant. In other words, prior solo teaching time and opportunity to learn time together account for some differences in learner cognitive attainment on a single instructional unit when prior

cognitive attainment of the learners and student teacher percentions are held constant.

The third test addressed to research question 3 compared the coefficients of determination for model 4 and 3. The F value for this comparison ($F = 11.11$, $p<.01$) indicates the explanatory power (2.6 percent of the variance) of the university supervisor's ratings is statistically significant. This finding indicates the planning and instructional competencies of the student teacher as perceived by the university supervisor do affect, to some degree, learner cognitive attainment when prior cognitive attainment, student teacher expectancies, and measures of instructional time are held constant. The aforementioned statistical comparisons for research questions 1, 2 and 3 are summarized in the following table.

Place table 1 about here

Coefficients of determination (R^2) and changes in R^2 presented in table 1 provide a basis for addressing the final research question of this investigation. While the first three research questions sought to determine the explanatory power of adding a particular variable or block of variables to a linear model to account for learner cognitive attainment, research question 4 directs our attention to the cumulative effect of the variables in the respective models, (R^2 for models in table 1), to explain the variance in learner cognitive attainment. Examining table 1 reveals that model 4 accounts for maximal variance, ($R^2 = .272$) at least among the models in this investigation. However, this model contains one independent variable, student teacher expectancy of learner cognitive ability, which contributes very little to the explanatory power of the model. Therefore, this variable was deleted from the system resulting in a new model with five independent variables. A statistical description of this new model is provided in table 2.

Place table 2 about here

As table 2 reveals, the following model has a multiple R which is statistically unequal to zero, $F = 45.44$, $p < .001$, and a substantial coefficient of determination ($R^2 = .267$).

$$Y_2 = -76.0111 + .539Y_1 + [.077T_1 + .035T_2] + [.784S_1 + .637S_2]$$

Symbols for the variables in this expression are identical to those for the models presented in figure 2, i.e., Y_1 = learner cognitive attainment on initial unit taught by student teacher, T_1 = prior solo teaching time of student teacher, T_2 = opportunity to learn time provided by student teacher in the second unit, S_1 = university supervisor quality ratings of instructional unit, S_2 = university supervisor quality ratings of the student teacher's instructional skills. The numerical values in the expression are partial regression coefficients (B) and the intercept term. These values represent the expected change in learner cognitive attainment when the value of the corresponding variable changes by one unit and all other variables remain constant. The significance of this expression for determining the competence of a student teacher is addressed in the following section.

DISCUSSION

While there are alternate means and standards for determining the competence of a student teacher, we have centered on the cognitive attainment of learners instructed by the student teacher as the criterion variable in determining this competence. To some educators, this approach places the fate of teachers or in this case, student teachers, in the hands of their learners who may not be motiviated or possess the prerequisite cognitive skills to succeed. Conversely, the contract plan described by McNeil and Popham (1973) which was incorporated

into the design of this investigation enables the teacher to account for the entry levels and dispositions of the learners in the development of a "learning contract." This point and counter-point represent only one facet of the multifaceted process of assessing a student teacher's competence. It was beyond the scope of this paper to examine the pro's and con's of this approach at length. Rather in this investigation, we have examined learner cognitive attainment in terms of variables commonly assessed during student teaching.

Research question one dealt with the issue of whether the expectancies of learners held by student teachers would affect the cognitive attainment of those learners in a single instructional unit. The results of this investigation indicate the "expectancies" held by the student teacher toward the class exerted little influence on the criterion variable.

It is possible that in order for expectancies of the teacher to affect learner cognitive attainment, the expectancy should be associated with a particular learner, not the class to which the learner belongs. On a positive note however, this finding supports the notion that self-awareness and control of one's expectancies of learner capability enable the student teacher to successfully control those "expectancies" during classroom instruction (Good, Brophy, 1973; Paulson, 1978). In terms of model building for assessing a learner's cognitive attainment, though, the explanatory power of this variable as defined in this investigation is so slight that it doesn't warrant inclusion in the model.

In contrast to the finding for research question 1, the results of the analyses for research questions two and three were statistically significant. These results encourage the inclusion of the variables examined in these

analyses in the model to explain a learner's cognitive attainment.

The block of time referenced variables addressed in research question 2, prior solo teaching time and opportunity-to-learn time, accounts for a small but sufficient amount of variance regarding learner cognitive attainment to be statistically significant. This result corresponds to the current literature on teacher effectiveness which underscores the importance of time-on-task on learner achievement (Medley, 1977; Stallings, 1977). While not specifically addressed in the literature, prior solo teaching time was included in this block of variables since the amount of previous instructional time in student teaching should affect the competence of the student teacher. This conjecture has merit if for no other reason than for the candidate gaining confidence and establishing a routine for managing the classroom during instruction. Further, data for these time based variables were obtained readily and easily from the student teacher's instructional plans and confirmed in the Summary Evaluation of Unit forms completed by the student teacher.

While the explanatory power of these variables is small, it is interesting that such global measures of instructional time account for enough variance in learner cognitive attainment to be statistically significant. Since these time measures did contribute to the explanatory power of the model, it is plausible that other time-based measures such as, student teacher planning time, student teacher time-on-instruction, and learner time-on-task may be fruitful extension of this research.

Similarly, values for the planning and instructional competence of the student teacher, the block of variables for research question 3, were readily obtained from the final evaluations of the university supervisor. Since the practice of evaluating the student teacher on the basis of supervisor ratings is so common, it is comforting to find these ratings do account for enough

variance regarding the cognitive attainment of learners to be statistically significant. On the other hand, an explanatory power of 2.6% of the variance fails to inspire a great deal of confidence in university supervisor ratings as a sole criterion for awarding a grade or certifying the teaching competence of a student teacher. Perhaps emphasis on observation data which provides frequencies of instructional procedures coupled with supervisory ratings would enhance the explanatory power of these ratings. Further, perceptional data from learners of student teachers on the instructional competence of the student teacher might be combined with supervisor ratings to enhance the explanatory power of these values. In any event, the practice of using university supervisor ratings as the only criteria for "grading" the student teacher is not supported by the results of this investigation.

The final research question directly addressed the issue of whether a group of variables closely associated with the student teaching experience may explain the cognitive attainment of learners in a single instructional unit planned and implemented by the student teacher. While the preceding discussion has accounted for the presence of four of the variables in the model, the most significant variable in the model has not been addressed. This variable, prior cognitive attainment of learners on a unit previously taught by the student teacher, provides a contribution that is comparable to the influence of prior achievement in determining school effects (Hanushek, 1972; Murnane, 1975). This variable enabled us to hold the effect of prior instruction constant, at least statistically speaking. The resulting linear model containing five variables explained nearly 27% of the variance in cognitive attainment of learners on a single instructional unit. At first glance, this result appears to be disappointing. However, one writer recently reported that only 9 percent of the researches published in a notable professional educational

research journal over the past twelve years accounted for 20% or more of the variance regarding the dependent measure under investigation (McNamara, 1978). Thus, the practical significance of this model in explaining learner cognitive attainment appears to be relatively high when compared to current research reports.

The model, which evolved from this investigation, clearly has associated learner cognitive attainment data with information collected during student teaching. However, it is wishful thinking to assume the model at this stage justifies assessing the competence of a student teacher solely in terms of learner cognitive attainment. On the positive side though, the model does provide a basis for integrating multiple sources of evaluative data and indicates empirically how these variables relate to learner cognitive attainment. Moreover, the investigation and the model in particular underscore the importance of collecting multiple sources of data on each teaching candidate. Certainly other variables not addressed in this investigation (Classroom observation summaries, learner perceptions of student teacher's competence, classroom supervisor ratings, unit pretest scores) may increase the explanatory power of a regression model on learner cognitive attainment and should be considered in future researches.

Further, this investigation has demonstrated that it is feasible to implement a McNeil-Popham type of contract plan in an ongoing student teaching program. In essence, the McNeil-Popham plan becomes a management system for implementing a student teaching program which collects cognitive attainment data from learners of student teachers. This plan has great potential not only for advancing teacher preparation practices but for instructional theory building as well.

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$$\text{model 1: } Y_2 = b_1Y_1 + a + E(1)$$

$$\text{model 2: } Y_2 = b_1Y_1 + b_2At + E(2)$$

$$\text{model 3: } Y_2 = b_1Y_1 + b_2At + [b_3T_1 + b_4T_2] + E(3)$$

$$\text{model 4: } Y_2 = b_1Y_1 + b_2At + [b_3T_1 + b_4T_2] + [b_5S_1 + b_6S_2] + E(4)$$

Y_2	=	learner cognitive attainment on the second unit developed and taught by a student teacher.
Y_1	=	learner cognitive attainment on the initial unit developed and taught by a student teacher.
At	=	student teacher expectancy of learner cognitive ability.
b_{1-6}	=	least squares weight associated with the six variables.
E(i)	=	the error-of-prediction vector for model i.
T1	=	prior solo teaching time of student teacher.
T2	=	opportunity to learn time provided by student teacher.
S1	=	university supervisor quality ratings of instructional unit.
S2	=	university supervisor quality ratings of the student teacher's instructional skills.

Figure 1

Four Regression models for Examining the Competence of Student Teachers

Generalized Expression: $F = \dfrac{[R^2_{i+1} - R^2_i] / M}{1 - R^2_{i+1} / N-K-L}$

Q1: $F = \dfrac{R^2_2 - R^2_1 / 1}{1 - R^2_2 / 626}$ Q2: $F = \dfrac{R^2_3 - R^2_2 / 2}{1 - R^2_3 / 624}$ Q3: $F = \dfrac{R^2_4 - R^2_3 / 2}{1 - R^2_4 / 622}$

R^2_i = coefficient of determination for model i (variance accounted for by model i)

N = the number of learners in the model (629)

K = total number of independent variables in the model (1 to 6)

M = number of independent variables in the subset for which the F test is being made. (1 to 2)

Figure 2

Generalized Expression and Corresponding F test Expressions for Research Questions 1-3.

Table 1

Summary of Data Used to Test Research Questions 1-3

Test Legend	Research Question 1	Research Question 2	Research Question 3
N	629	629	629
K	2	4	6
M	1	2	2
R^2 from model 1	.232	--	--
R^2 from model 2	.233	.233	--
R^2 from model 3	--	.246	.246
R^2 from model 4	--	--	.272
$R^2_{i+1} - R^2_i$	.001	.013	.026
F Statistic	$F(1,626)_{.82}$	$F(2,624)_{5.38}$*	$F(2,622)_{11.11}$*

*α>.01

Table 2

Statistical Summary of Regression Model for Explaining a Learner's Cognitive Attainment on a Single Instructional Unit

Multiple R	.517	Analysis of Variance	Df	MS	F
R^2	.267	Regression	5	36011.43	45.44
Std. Error	28.150	Residual	623	792.43	

Variable	B	BETA	STD Error B
Y_1	.539	.505	.039
T_1	.077	.225	.020
T_2	.035	.092	.022
S_1	.784	.146	.255
S_2	.637	.071	.318
intercept - 76.011			

Table 2

Statistical Summary of Regression Model for Explaining a Learner's Cognitive Attainment on a Single Instructional Unit

Multiple R	.517	Analysis of Variance	Df	MS	F
R^2	.267	Regression	5	36011.43	45.44
Std. Error	28.150	Residual	623	792.43	

Variable	B	BETA	STD Error B
Y_1	.539	.505	.039
T_1	.077	.225	.020
T_2	.035	.092	.022
S_1	.784	.146	.255
S_2	.637	.071	.318
intercept - 76.011			